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Mobile Applications and Multi-User Virtual Reality Simulations

**Abstract**

This is my third internship with NASA and my second one at the Johnson Space Center. I work within the engineering directorate in ER7 (Software Robotics and Simulations Division) at a graphics lab called IGOAL. We are a very well-rounded lab because we have dedicated software developers and dedicated 3D artist, and when you combine the two, what you get is the ability to create many different things such as interactive simulations, 3D models, animations, and mobile applications.

One of the mobile applications, available now on IOS and Android, is the SSRE (Space Station Research Explorer). It's an outreach application that allows for everyone to see photos, history and details about experiments previously and currently onboard the ISS. At this time, there is only an interactive model of the internal facilities (Columbus, Kibō, and Destiny) but not the externals.  Hansen Tapaha and I were assigned to create the scene for the external facilities (four ELC's, AMS, JEM-EF, and Columbus-EPF). We performed research on the experiments to determine the position of them on the facility. Unlike the internals, the external facilities can hold more than one experiment per slot. As a result, I wrote functions to allow for the dynamic creation of experiments inside of a scroll view (window frame) that was only intended to handle one. A lot of the functionality we would need for our interactive 3D model was already available, such as the ability to query a database for experiment data or handle inputs like touches or swipes. The scenes are very similar but there were a lot of differences that required new scripts and modifications to existing code. I also wrote scripts that re-parent the components of the ISS so that the external facility is also the pivot point for the rotation. We successfully finished a working version of the scene and our contributions will be launched with the next app update in September.

During the last 5 weeks of this internship I've also been working on a multi-user virtual reality simulation. This simulation is of the ISS between 4 operators running remotely in different locations but interact seamlessly in one virtual environment. There's an operator controlling the Canada arm with the actual kind of controllers one would use to do that. The second operator is in the Cupola with a distance gun, taking measurements. The third operator is navigating an astronaut practicing a SAFER mission. The SAFER mission is a lot like the Sandra Bullock scenario from gravity, an astronaut's tether breaks while performing a spacewalk and they must find a way to navigate back to the ISS using the spacesuit equipment. Then there is us, a simulation of an astronaut doing an

EVA on the hand rails of the JEM. We have the real physical handrails in the lab mapped to our virtual environment, so that when you reach out to grab these handrails, they are actually there. It convinces the mind that you can trust the simulation. My task was to use the Unity platform along with an external library called SteamVR to send our hardware's transformation data back to the server, and then the server broadcasts our data to the entire simulation. Our hardware included a headset, two controllers, and a back controller. A challenge for this project was that because we are working on a cross platform virtual environment, some environments have different world coordinate systems. This means that some use the right hand rule, where the z-axis is coming out of the screen, and others use the left hand rule, where the z-axis is going into the screen. Hung Nguyen, from the TRICK lab, showed me how to apply the linear algebra I've been learning at school to this real world matrix problem. By solving for the resulting matrix we know what the data coming out of our simulation should look like. Another amazing part of this project was meeting an astronaut, Michael Hopkins, and suiting him up with our VR gear. He gave us some valuable tips about where the head should be in relation to the inside of the virtual space helmet. After applying these adjustments, it added that much more to the simulation. Then NASA takes this project one step further by integrating ARGOS into our portion of the simulation. ARGOS can simulate different gravity and combining that with our multi user simulation and the physical handrails and an astronaut's advice, you get a believable immersive experience of a spacewalk.

This semester has been a blast; the people I've worked with are the most helpful type of people. My lab is at the level of experience and discipline that I hope to reach someday. It was truly an honor to contribute doing what I love for something that is so much bigger than any one person.